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## RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	8/16/04	Initial issue.	Kelly Bingham, <i>FWO-DECS</i>	Gurinder Grewal, <i>FWO-DO</i>
1	5/18/05	Change LANL welder designation	Kelly Bingham, <i>ENG-DECS</i>	Gurinder Grewal, <i>ENG-DO</i>
2	10/27/06	Administrative changes only. Organization updates from LANS transition. IMP/ ISD number changes based on new Conduct of Engineering IMP 341. Other administrative changes.	Kelly Bingham, <i>FM&amp;E-DES</i>	Kirk Christensen, <i>CENG</i>
3	6/06/08	Corrected audit deficiencies; clarifications	Kelly Bingham <i>ES-DE</i>	Kirk Christensen, <i>CENG</i>

**Contact the Welding Standards POC for upkeep, interpretation, and variance issues**

<b>GWS 1-05</b>	<a href="#"><u>Welding POC/Committee</u></a>
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## **GWS 1-05 WELDER PERFORMANCE QUALIFICATION & CERTIFICATION**

### **1.0 PURPOSE, SCOPE, AND POLICY STATEMENT**

- A. The purpose of this section is to establish the responsibilities, methods, and examination requirements for conducting performance qualification testing and certification of welders as approved by LANL WPA.
- B. The scope of this section is welder qualification activities performed for or under the LANL Welding Program.
- C. Policy - Welders working on site at LANL will be qualified at the LANL test facility using the welder qualification practices prescribed in this procedure or as authorized by the WPA.

### **2.0 REFERENCES**

- 1. ASME Section IX, *Welding and Brazing Qualifications*
- 2. AWS D1.1, *Structural Welding Code*
- 3. API-1104, *Welding of Pipelines and Related Facilities*

### **3.0 ACRONYMS AND DEFINITIONS**

<b>Acronym / Term</b>	<b>Description</b>
<b>Welder Certification</b> (also Certified Welder)	Written Certification that a welder has produced welds meeting a prescribed standard of welder performance. (see also Welder qualification)
<b>Welder Qualification</b> (also Welder Performance Qualification)	The demonstration of a welder's or welding operator's ability to produce welds meeting prescribed standards. (normally by hands on test)
<b>Welding Qualification Test (WQT)</b>	criteria for welder performance qualification tests
<b>Welder</b>	One who performs manual or semiautomatic welding. Within the LANL Welding Program, the term Welder also applies to welding operator, brazer, and brazing operator, as appropriate to the context of use.
<b>Welder Identification Symbol</b>	Welders will use their Z Number as a unique identifier and welder identification symbol
<b>Employer Designation</b>	The welder's employer will be recorded and entered in to the Welder Qualification Database when they pass a qualification test.

Acronym / Term	Description	
Craft Designation	A determination will be made by the test supervisor and data entered in to the Welder Qualification Database as to each welder’s work category.	
	Boilermaker - BM	Pipefitter - PF
	Millwright - MW	Ironworker - IW
	Electrician - EL	Sheetmetal Worker - SM
	Mechanic - ME	LANL Welder - LW

## 4.0 GENERAL

### 4.1 Responsibilities

- A. The **LANL WPA** is responsible to designate Welding Test Supervisors. The WPA shall also be responsible to develop new and revised Welder Qualification Tests (WQTs) in support of welder performance qualification requirements.
- B. The **LANL QA-IA group** is responsible for auditing activities relating to Welder Qualification Tests (WQTs).
- C. The LANL-designated **Welding Test Supervisor** is responsible for conducting welder qualification tests; inspect test coupons, and preparing records of test results and welder certification, including database entry and maintenance of welder certification continuity. Test Supervisors will also direct welder to use their Z Number as unique identification symbol for the welds made by them.
- D. The **LANL Facility, Program/Project Managers or supervisors, and SSS Craft Supervisors, and Subcontractors** are responsible for determining specific applications of planned welding activities and assignment of currently certified welding personnel as appropriate. In cases where determination cannot be made, welding shall not commence without first contacting the LANL WPA.
- E. Each **Certified Welder** is responsible for performing only welding or brazing for which they are properly and currently qualified and to identify welds made with their assigned symbol in a manner directed by the LANL Facility, Program/Project Managers or supervisors, and SSS Craft supervisors or foremen.
  - Welder Certification requires each welder to complete Training Plans 2310, 9780, and 2302 if compressed gases are used for a certified welding process.

*Guidance note: Welder certifications can be verified at*

<http://zirk/weldersdb/engstandard.aspx>

- F. The **Support Services Subcontractor (SSS)** is responsible for providing facilities and resources in support of welder performance qualification activities for LANL and authorized subcontractors.

## **5.0 QUALIFICATION REQUIREMENTS**

- A. Personnel responsible for conducting welder qualification tests shall be AWS-CWIs or knowledgeable in the activity based on previous experience or training equal to an AWS-CWI and approved by the LANL WPA.
- B. Permanent welding, including tack welds, shall be performed by certified welders with acceptable qualification records on file. Certified welders may be not required for those welding activities listed in GWS 1-01, *Introduction and Scope*, Paragraph 5.3 Exclusions.
- C. Unless otherwise established in governing documents, the WQTs described herein are to be considered reciprocal qualifications to allow welding to be performed within the essential variables (e.g. processes, materials, thicknesses, etc.) under the following standards or codes.
  - ANSI – American National Standards Institute
  - AWWA – American Water Works Association
  - API – American Petroleum Institute
  - AISC – American Institute of Steel Construction
  - AGA – American Gas Association
  - ASME – American Society of Mechanical Engineers
  - AWS – American Welding Society
  - DOT – Department of Transportation
  - DOD – Department of Defense
- D. For AWS welder qualification, the LANL WPA may accept evidence of previous qualifications in lieu of conducting qualification testing. Acceptance based on previous qualifications shall be supported by evidence of the welder's actual test certification and performance of production welding within the past six months. Documentation of production welding must include a statement by the previous employer(s) of each process used and dates welded.
- E. Where permitted by fabrication codes (e.g. ASME B31.1, B31.3, AWS D1.1, etc.), the LANL WPA may accept evidence of welder qualification from a previous employer in lieu of conducting qualification testing. Acceptance based on previous qualification shall meet the following criteria.
  - 1. The LANL WPA shall provide cross-reference information to LANL's program to assure the same or an equivalent procedure is used wherein the essential variables are within the limits established by AWS or ASME Section IX (Reference 2.1).
  - 2. A copy of the welder performance qualification shall be obtained from the previous employer, indicating the name of the employer by whom the welder was qualified, the date of qualification, and evidence that continuity of the welder's qualification has been maintained (see Section 6.9).
  - 3. The LANL WPA shall complete the records required by Section 6.4 to accept responsibility for the ability of the welder.

## **6.0 PROCEDURE**

### **6.1 Test Facility**

A. The test facility shall include the following, as a minimum:

- welding and cutting equipment
- grinders and other hand tools
- welding shields and gloves
- booths and welding fixtures suitable for the required tests
- welding electrode storage ovens
- shielding and purging gas, as required
- storage facilities for tools, equipment, and test coupons
- low-stress stamps, vibro-etching tool, or marking devices

### **6.2 Test Requirements**

- A. The Welder's Supervisor or Foreman shall send requests for welder qualification to the LANL-designated Welding Test Supervisor using a Welder Qualification Test Request (Attachment 1). The request shall include the welder's name, employee number, craft, authorized signature, welder qualification test (WQT) to which the welder is to be tested, and date the test is required. The Welding Test Supervisor shall review the request and advise the Foreman or Supervisor of the acceptable test date, and schedule the test with the assigned Test Supervisor. See Attachment 2 for an Index of Welder Qualification Tests and Attachment 3 for Standard Qualification Tests by Craft.
- B. Subcontractors shall request welder certification using a Welder Qualification Test Request (Attachment 1). The request shall include the welder's name, employee number, craft, contractors authorized signature, LANL Program/Project authorized signature, welder qualification test (WQT) to which the welder is to be tested, and date the test is required. The Welding Test Supervisor shall review the request and advise the Foreman or Supervisor of the acceptable test date, and schedule the test with the assigned Test Supervisor. See Attachment 2 for an Index of Welder Qualification Tests and Attachment 3 for Standard Qualification Tests by Craft.
- C. Welders reporting for testing shall log in with the LANL Welding Test Supervisor. The Welding Test Supervisor shall interview applicant welders for previous experience and knowledge. Based on this evaluation, the Welding Test Supervisor may require a pretest fillet weld demonstration or may proceed with the qualification test. When requested by supervision, welder training shall be provided in accordance with GWS 1-10, *Welder Training and Testing*. Prior to initiating the test, the Welding Test Supervisor shall provide the welder with:
- orientation in welding procedure requirements (i.e., welding in rain, weld joint cleaning, undercut requirements)
  - applicable Welder Qualification Test and Welding Technique Sheet, and an explanation of their functions (i.e., where to find amperage and voltage ranges, preheat requirements, interpass temperature requirements)
  - information on welding equipment operation
  - information on grinding requirements

- an explanation of site rules of conduct and safety
- welding shield and gloves
- electrodes and scrap material so that the welder may “warm-up”

### **6.3 Supervising the Test**

- A. The Welding Test Supervisor shall oversee qualification tests in accordance with the following:
1. Provide the welder with welding materials to be used in performance of the test weld(s).
  2. Observe the welder during set-up of the test coupon to verify that the test is in compliance with the WQT and applicable Welding Technique Sheet. Verification shall include that the test is performed in the correct position (see Attachments 4 through 9, as applicable), that fit-up and tack welds are acceptable, the welder used the proper electrode, and that the welder achieves the preheat temperature.
  3. Observe the welder during welding of the test coupon to verify acceptable completion. Verification shall include acceptance of the root pass, and maintenance of preheat and interpass temperature requirements.
  4. Terminate the qualification test whenever it becomes apparent that the welder does not have the required ability to produce acceptable results.
  5. Discontinue and initiate a new qualification test if a problem occurs which is not related to the welder's ability to perform the test correctly (e.g. accidental loss of shielding or purge gas, welding equipment malfunction).
- B. Identification of Test Coupon:
1. The Welding Test Supervisor shall inform the welder how to apply the required identification to the coupon(s). The welder's employee number or social security number (if an employee number has not been issued), test position, and WQT number shall be marked on the test coupon with a low-stress stamp, vibro-etching tool, pneumatic scribe, or suitable marking pen. If pipe, mark the letter “T,” for top, on the top of the test coupon. If bend specimens are required, each specimen shall be marked as above and with the type of bend test required (i.e. face, root, or side bend). The Welding Test Supervisor shall check to ensure that the identification is correctly and legibly applied.
- C. Physical Testing of Coupons:
1. The Welding Test Supervisor shall determine the method of physical testing in accordance with the WQT requirements. The welder shall perform specimen removal and preparation of the coupon(s). The Welding Test Supervisor shall visually inspect the coupon specimens in accordance with Attachment 4, Qualification Test Acceptance Criteria.
  2. When bend tests are selected, the coupons shall be cut and prepared in accordance with Attachment 9. Side bend test coupon specimens shall be positioned such that the side with the most visible defects shall become the convex side.
  3. When radiography is selected, it shall be performed under the supervision or surveillance of an ASNT TC-1A Level II Inspector. The Level II Inspector shall interpret the radiographs and shall submit an interpretation sheet to the Welding Test Supervisor who shall perform the final acceptance of the radiograph in accordance with the criteria

indicated in Attachment 4, Qualification Test Acceptance Criteria and the results of the certified Level II Inspector's interpretation. See Attachments 10 and 11.

**D. API 1104 Single Qualification:**

1. The welder shall make a test weld to join pipe nipples or segment of pipe nipples using a butt weld in either the fixed or rolled position. When the welder is qualifying in the fixed position the axis of the pipe shall be horizontal, vertical, or inclined at not more than 45° from horizontal.
2. The type and number of butt weld test specimens required for welder performance qualification shall be in accordance with the following.

Pipe OD		Number of Specimens					
		Tensile Strength	Nick - Break	Root Bend	Face Bend	Side Bend	Total
in.	Mm	Wall Thickness < ½ in. (12.7 mm)					
< 2 ³⁄₈	< 60.3	0	2	2	0	0	4a
2 ³⁄₈ to 4 ½	60.3 to 114.3	0	2	2	0	0	4
> 4 ½ to 12 ¾	114.3 to 323.9	2	2	2	2	0	8
> 12 ¾	> 323.9	4	4	2	2	0	12
		Wall Thickness > ½ in. (12.7 mm)					
< 4 ½	< 114.3	0	2	0	0	2	4
> 4 ½ to 12 ¾	> 114.3 to 323.9	2	2	0	0	4	8
> 12 ¾	> 322.9	4	4	0	0	4	12
<b>Note</b> - For pipe less than or equal to 1.315 in. (33.4 mm) in OD, specimens from two welds or one full-section tensile-strength specimen shall be taken.							

**3. Requalification is required when there is any change in the following variables:**

- Welding process or combination of processes.
- Welding direction, i.e. uphill to downhill or vice versa.
- Filler metal Group 1 and 2 to Group 3, or vice versa.
- OD range, i.e. < 2 ³⁄₈ in. (60.3 mm), 2 ³⁄₈ in. to 12 ¾ in. (60.3 mm to 323.9 mm), or > 12 ¾ in. (323.9 mm).
- Wall thickness range, i.e. < ³⁄₁₆ in. (4.8 mm), ³⁄₁₆ in. to ¾ in. (4.8 mm to 19.1 mm), or > ¾ in. (19.1 mm).
- Position, e.g. rolled to fixed, vertical to horizontal.
- Joint design, e.g. elimination of backing, V bevel to U bevel.

**E. API 1104 Multiple Qualifications:**

1. First test – The welder shall make a butt weld in the fixed position with the axis of the pipe horizontal or inclined at not more than 45°. The pipe shall be at least 6 ⁵⁄₈ in. (168.3 mm) OD with a wall thickness of at least ¼ in. (6.4 mm), and welded without backing.
2. Second test – The welder shall layout, cut, fit and weld a full size branch on pipe connection. The pipe shall be at least 6 ⁵⁄₈ in. (168.3 mm) OD with a wall thickness of at least ¼ in. (6.4 mm). A full size hole shall be cut in the run. The weld shall be made with the run pipe axis in the horizontal position and the branch pipe axis extending vertical down.



3. The type and number of required test specimens shall be in accordance with Section 6.3D(2).
4. A welder that successfully completes a butt weld qualification on pipe with a diameter  $\geq 12 \frac{3}{4}$  in. (323.9 mm) and a full size branch connection on a pipe  $\geq 12 \frac{3}{4}$  in. (323.9 mm) shall be qualified to weld all positions, thicknesses, joint designs, and fittings on all pipe diameters. A welder that successfully completes a butt weld qualification on pipe with a diameter  $< 12 \frac{3}{4}$  in. (323.9 mm) shall be qualified to weld all positions, thicknesses, joint designs, and fittings on pipe diameters less than or equal to the diameter used during the qualification test.
5. Requalification is required when there is any change in the following variables:
  - Welding process or combination of processes.
  - Welding direction, i.e. uphill to downhill or vice versa.
  - Filler metal Group 1 and 2 to Group 3, or vice versa.
- F. Welders who pass the required tests for pipe groove welds shall also be qualified to make fillet welds in all thicknesses and pipe diameters of any size within the limits of the welding variables of a specific Welding Procedure Specification (WPS) or Welding Technique Sheet (WTS). NOTE: Welding tests for only fillet welds are not permitted under the LANL Welding Program.
- G. For sheet metal qualifications, a qualification test performed on 18 gage (0.051 in.) metal shall provide qualification for the welder for metals 16 gage (0.064 in.) and thinner. A qualification weld performed on 10 gage (0.138 in.) or thicker metal shall provide qualification for metals 16 gage (0.064 in.) and thicker up to 2t thickness, where t is the thickness of the thinner sheet welded.
- H. Brazing operators who perform qualification tests on 1/16 in. (1.5 mm) wall tube/pipe are qualified to braze on thicknesses of 1/32 in. (0.8 mm) through 1/8 in. (3 mm).
- I. Base material used for welder qualification may be substituted for the P-Number material specified in the Welding Procedure Specification (WPS) or Welding Technique Sheet (WTS) in accordance with the following:

<b>Base Metal(s) for Welder Qualification</b>	<b>Qualified Production Base Metal(s)</b>
P-No. 1 through P-No. 11 and P-No. 4x	P-No.1 through P- No. 11 and P-No. 4x
P-No. 21 through P-No. 25	P-No. 21 through P-No. 25
P-No. 52	P-No. 51 and P-No. 52
P-No. 62	P-No. 61 and P-No. 62

- J. Test coupons (pass or fail) and radiographs shall be maintained until viewed by the welder or 30 days from date of qualification or re-qualification, whichever is earlier.
- K. Test Failure:
  1. If a test is unsuccessful, the Welding Test Supervisor shall complete the applicable Welder Performance Qualification Test Record (Attachment 12, 13, or 14) only if the welder is to remain employed at LANL. If radiography is performed for qualification, the radiographic interpretation sheet shall be maintained with the Welder Performance Qualification Test Record. These records shall be maintained for as long as the welder is employed at LANL. The forms must include the reason for test failure.



2. Records of failed WQTs, for welders attempting qualification as a condition of employment but who were not hired, are not required.
3. Failed weld bend test coupons or failed x-ray test film are be retained in accordance with Section 6.3F.

#### **6.4 Records**

- A. The Welder Certification Test Record File has two sections, one for active welders and the other for inactive welders. These sections should also be separated into craft groups so that all craft welders are grouped together.
- B. Records of welders later terminated or welders whose qualifications have expired (see Section 6.6) should be separated from active welders and maintained in the inactive file.
- C. Test Passed:
  1. When the qualification test is successfully completed, the Welding Test Supervisor, shall assure records are completed for the following:
    - QW-484, Record of Welder Qualification for ASME IX Tests (Attachment 12)
    - AWS D1.1, *Welder and Welding Operator Qualification Test Record* (Attachment 13) and/or API Coupon Test Report (Attachment 14), as applicable
    - Welder Qualification History Log (Attachment 15)
    - Welder Identification Symbol Log (Attachment 16)
  2. The subject records shall be maintained in a site file by the LANL WPA or designee for each welder as long as the welder is employed by LANL or the SSS. A copy of Attachment 12, 13, or 14 as applicable shall be maintained on file with the original provided to the welder. If radiography is used for qualification, the film interpretation sheet shall be maintained with the Welder Performance Qualification Test Record. The radiographic film may be discarded after the documentation is completed. If weld bend tests are used for qualification, the weld bend test straps may be discarded after the documentation is completed. See Section 6.3F.
  3. The LANL WPA shall assure welder qualification records are entered and maintained in the welder qualification database.

#### **6.5 Welder Identification Symbol Stamp**

- A. The Welding Test Supervisor shall be responsible to assure that each qualified welder knows to use their Z-number as a unique welder identification symbol (see Section 3.0 and Attachment 16). The Welding Test Supervisor shall also be responsible for instructing the welders in the use of the identification symbol (Z-number). The welder will identify each weld by hard marking on the weld or making a record traceable to the weld. This record may be an isometric drawing or a weld traveler.
- B. For welds that require nondestructive examination (NDE), the welder's Z-number shall be required on the weld data record; however, it is recommended that welder's hard mark all welds performed by the welder.
- C. For welds performed to fabrication/construction codes and not requiring NDE, the welder may apply their Z-number adjacent to the weld area, in accordance with the following:

1. Preferred Method - Material less than ¼ in. (6 mm) thick shall have welder's Z-number applied to the weld joint area with an electric vibro-etching tool or pneumatic scribe or low stress steel stamps. The Z-number shall be applied on the base material approximately 2 in. (50 mm) from the edge of the weld. The LANL WPA or the Welding Test Supervisor may determine that welders will be issued only an electric vibro-etching tool or pneumatic scribe and not issued Z-number stamps to identify their welds.  
Alternate Method - The welder will identify each weld by making a record traceable to the weld. This record may be an isometric drawing or a weld traveler.
  2. Preferred Method - Material ¼ in. (6 mm) and greater in thickness shall have the Z-number applied to the weld joint area with the stamp or other means. The Z-number shall be applied on the base material approximately 2 in. (50 mm) from the edge of the weld.  
Alternate Method - The welder will identify each weld by making a record traceable to the weld. This record may be an isometric drawing or a weld traveler.
- D. Where more than one welder has worked on the same weld joint, the Z-number of each welder shall be applied directly below the previous welder's Z-number.
- E. If a welder's Z-number stamp is lost, a new stamp shall be issued noting the issue date in the symbol log.
- F. When welders do not and will not have a Z number, another sequential number will be assigned (*e.g., 000001, 000002, etc.*).

## **6.6 Retests**

- A. At the discretion of the Welding Test Supervisor a welder who has failed a qualification test may be retested, as follows:
- B. The Welding Test Supervisor shall review the failed WQT test specimens or radiographs to determine the conditions that contributed to the test failure.
- C. In circumstances where a welder exhibits the ability to perform sound welds but failed the test due to personal conditions or technique, which produced nonconformances, the Welding Test Supervisor, may provide training or practice designed to improve the welder's ability prior to retesting. The training/practice may continue, up to a maximum of 8 hours, until the Welding Test Supervisor is satisfied that the welder has adequately demonstrated improvements to justify a retest. The welder shall be retested in accordance with the original failed WQT. Should the retest fail, the welder's qualification cycle shall be terminated.
- D. Retesting without additional training or practice is not recommended; however, if this approach is approved and requested by the welder's supervision, two consecutive tests shall be performed in accordance with the failed WQT. The weld test method, bend test or radiography, shall be same method used during the failed qualification attempt. Each test coupon must pass the test requirements to qualify the welder. This retest may be administered to the welder up to 5 working days from the time of failure. Retest for second time failures of the same WQT shall not be permitted without demonstrated training and/or practice.
- E. Terminated welders who fail the WQT test and are rehired shall be re-tested in accordance with the initial qualification requirements of this procedure.

**6.7 Updating of Welder Certification**

- A. An update of the welder certification files and database shall be performed at least one time each month by the LANL WPA or designee. The Welder Qualification History Log (Attachment 15) may be used for welder qualification updates. Alternatively, electronic tracking of welder qualifications may be maintained. Welder qualification updates shall be performed to ensure that welders employed at the site remain qualified and do not have to renew their qualifications. If at the time of qualification update it is determined that the welder has not welded with a process since the last update, the assigned supervisor or craft supervisor should ensure that the welder uses the process to prevent expiration of the welder's certification(s).

**6.8 Renewal / Requalification**

- A. When a welder has not welded with a process during a period of 6 months or more, the welder's qualifications for that process shall expire.
- B. Within the 6 month period prior to the welder's expiration of qualification:
  - 1. A welder who welds using a manual or semi-automatic process will maintain qualification for manual and semi-automatic welding with that process.
  - 2. A welding operator who welds with a machine or automatic process will maintain qualification for machine and automatic welding with that process.
- C. Each LANL department employing welders is responsible to provide objective written evidence to the LANL WPA for maintenance of welder qualifications. This will be attested to by the welder's Facility, Program/Project Managers or supervisors, and SSS Craft supervisors or foremen, which each welder has performed welding in each of the processes for which they are currently qualified within the time limits defined in Section 6.9.B. This may be accomplished by submittal of a Weld Material Requisition or Weld Material Control Log indicating the welder has performed welding with the specific welding process. The LANL WPA or designee shall update welder qualification history and/or database accordingly.
- D. When there is a specific reason to question a welder's ability to make welds that conform to the welding procedure, the welder's qualifications for the process(es) associated with the welding shall be revoked. Other qualifications not questioned shall remain in effect.
- E. When a welder's qualification in a specific process has expired, renewal of that qualification may be made by making one satisfactory test joint weld (plate or pipe) on any thickness (3/8 in. (10 mm) plate for AWS D1.1), position, or material with that process. This will reestablish the welder's qualification in the specific process for any previously qualified thickness, position, or material.
- F. Welders who fail the renewal test in a process, or who have their qualifications revoked (see Section 6.9.D), must qualify in accordance with the initial qualification requirements of this procedure prior to further production welding with that process.

**6.9 Rehire and Reinstatement**

- A. A welder who was previously certified by or for LANL may have their qualifications reinstated upon rehire, when it is verified that the welder is still within the effective qualification period (i.e., 6 months for ASME or AWS Codes).

- B. Rehired welders whose LANL qualifications have expired (i.e. are not current within the 6 month qualification period) shall renew their qualifications in accordance with Section 6.8.E. Rehired welders who fail the renewal test must qualify in accordance with the initial testing requirements of this procedure.

## **7.0 ATTACHMENTS**

Attachment 1: Welder Qualification Test Request

Attachment 2: Index of Welder Qualification Tests

Attachment 3: Standard Qualification Tests by Craft

Attachment 4: Qualification Test Acceptance Criteria

Attachment 5: ASME IX Test Positions

Attachment 6: AWS D1.1 Test Positions

Attachment 7: AWS D9.1 Test Positions

Attachment 8: Brazing Test Flow Positions

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Attachment 10: ASME Rounded Indication Charts

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